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HIGHLIGHTS OF THE ANNUAL MEETING OF THE AMERICAN PHYSICAL SOCIETY HELD IN NEW YORK, JANUARY 27-30, 1965

by

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INTRODUCTION

This report contains some of the highlights of the Mössbauer Effect Symposium held on January 26 and also of the Annual Meeting of the American Physical Society (APS) held in New York January 27-30, 1965. The Mössbauer Effect Symposium was attended by over 100 people and the APS meeting by over 6000 members.

THE MÖSSBAUER EFFECT SYMPOSIUM

This symposium, sponsored jointly by Technical Measurements Corporation and New England Nuclear Company, dealt primarily with methodology rather than experimental results. The first 3 papers were summaries of the state of the art in chemistry, physics and biology.

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Chemistry

Dr. R. Herber of Rutgers led the discussion on chemistry. Here the principal parameter of interest is the isomer shift, which is a measure of the relative s electron densities at the nucleus of the source and absorber. The isomer shift gives information regarding bonding and ligand strengths. There is still much to be done in this field and as yet only relative measurements have been made. The need for a standard compared to which isomer shifts are quoted was stressed. Since the isomer shift is sensitive to details of the wave function, there are few compounds which will exhibit an isomer shift which is independent of their history and preparation. This problem has not as yet been resolved, although sodium nitroprusside has been suggested as a possible solution.

Physics

Recent advances in physics using the Mössbauer effect were presented by Dr. S.L. Ruby of the Argonne National Laboratory. He discussed what was expected in 1960 and how well this has been achieved at present. Progress has been much slower, and many difficulties in interpretation have occurred that were not forecast 4 years ago. It was thought that the Mössbauer effect would help greatly in the understanding of magnetism. In fact, these experiments have done little to increase our knowledge in this field. Work on the Mössbauer effect in conjunction with high pressures has been most useful and this field shows much promise for

the future. Four years ago it was felt that about 10 isotopes would be useful in Mössbauer effect work; there are now 24 isotopes which have shown the effect. Work on different isotopes of the same material have allowed the accurate determination of quadrupole interactions. Particular mention was made of the I^{127} and I^{129} pair. The work on the Xenonates has also shown the power of the Mössbauer effect in studying transient phenomena which are not amenable to classical chemistry. Mainly because of the problem of obtaining large single crystal material, work on single crystals has been slow. There is still much to be done with the Mössbauer effect and the theoretical interpretation lags behind experimental results.

Biology

The use of the Mössbauer effect in biology was discussed by U. Gonser of the North American Aviation Science Centre. He described the Mössbauer effect of Fe^{57} in hemogloben as a function of dissolved gases. Little interpretation was given.

Instrumentation

The next session was devoted to velocity drives. Dr. E. Kankelheit of the University of California described an analysis of the stability conditions for a loudspeaker feedback system. The Nyquist diagram showed many singularities as a function of frequency and revealed the general complexity of the problem. It was possible to obtain feedback factors of about 2500 before serious instability was observed. Higher

values of this factor require many filters and a stable mechanical system.

The truly mechanical Mössbauer velocity drive is in general either a "lathe" type or a "cam" type system. Dr. A. Bearden, formerly of Cornell, and now at University of California (La Jolla), described a cam type system. He used a circular cam driven off centre. This produces a constant acceleration (velocity sweep) system for about 27 per cent of the rotation. The acceleration is constant to 0.5 per cent, and that data is taken on a multi-channel analyser operated in the synchronized time mode. This unit is simple and reliable but is somewhat wasteful of experimental time.

A system which combines both an electronic and mechanical system was described by Dr. P.A. Flinn of Carnegie Institute of Technology. This is a pendulum device forced, electronically, to run at a constant velocity. The velocity was measured using the self-imaging Moiré fringe technique which consists of a set of alternate opaque and clear strips. As these move with respect to their image, the total intensity will vary from maximum to zero. Thus the frequency of change of intensity is a measure of the velocity of the pendulum. Flinn emphasized the value of a constant velocity system, in that only the desired regions of a velocity spectrum need to be examined. Dr. M.P. Klein suggested the use of a laser and simple interference techniques for the velocity measurement. Several people thought this would be useful.

New Techniques

The next group of papers were given by Dr. J. Major of Western Reserve University and Dr. P. Debrunner of the University of Illinois who considered the use of scattered rather than absorbed radiation for obtaining Mössbauer spectra. These techniques require the reduction of background scattered radiation and are chiefly useful for high energy transitions. For transmission, the maximum size of the Mössbauer effect is f, the recoilless fraction for scattering, the effect may be much larger if other scattering cross-sections are small. Scattering requires large sources and a great deal of shielding. This imposes severe problems on the velocity drive system.

Dr. J. Dash of the University of Washington presented an interesting paper on the use of black absorbers. This technique allows the measurement of the recoillers fraction f, as a function of temperature without using a velocity drive or a pulse height analyser. It is unfortunate that this information in itself is not particularly useful. A black absorber has a broad flat absorption spectrum about 2 mm /sec wide, and thus the total singlet or quadrupole splitting will be absorbed. The most commonly used absorber is ammonium-lithium fluoferrate.

A most interesting summary of calculations of Mössbauer spectra was given by Dr. J. Gabriel of the Argonne National Laboratory. He has calculated expected Mössbauer spectra for single crystal and powder material with and without an external field. The agreement between his calculations and experiment is quite good. He is going to send a deck of

cards for his program and also his "small quantum mechanics" program for ligand field calculations.

The next two papers concerned the use of superconducting and Bitter-solenoid magnets in Mössbauer experiments. At sufficiently high fields, only certain values of ΔM are possible and thus the spectra are simplified. Several problems arise in using superconducting magnets: they have a very small bore in general and they must be operated at liquid helium temperatures. Dr. M. Kalvius of Western Reserve University discussed low temperature measurements but there was little new in this field. Dr. R. Ingalls presented a paper on high pressure techniques and the Mössbauer effect. Using a modified Bridgeman anvil, capable of exerting pressures of up to 240 kilobars, he studied phase transitions. Due to the small solid angle,only the source could be compressed. The results of squeezing the lattice were easily seen and this field shows much promise for the future.

Dr. J. Spijkerman of the National Bureau of Standards presented a paper on absolute velocity measurements using his interference techniques. He also discussed the finite angle correction in Mössbauer effect experiments.

The discussion after the meeting was most useful and informative. Ge^{73} is still a problem, especially the preparation of sources. Technical Measurements Corporation displayed a loudspeaker type velocity drive and used the iron-in-iron for demonstration purposes – a nice system but rather expensive. Mr. A.J. Lin, a graduate student of the University of Toronto, is working on the Mössbauer effect in invar. He said that he is

having trouble with his Nuclear Data analyser in this application.

THE ANNUAL MEETING OF THE AMERICAN PHYSICAL SOCIETY

The abstracts for the papers presented at this meeting are found in the Bulletin of the American Physical Society, Series II 10, No. 1 (1965). There are a few papers which are of special interest and these will be briefly commented upon.

A very interesting paper was given by Dr. H.H. Wickman of the Bell Telephone Laboratories on a theoretical calculation of Mössbauer effect. Below 4°K, the intensities of a paramagnetic 6 line spectrum were calculated since at this temperature the spin dependent relaxation time is long. As the temperature is increased the 6 lines gradually change. The innermost lines increased at the expense of the outerlines and eventually, near room temperature, a single peak was predicted. These calculations are confirmed by experiment.

The Mössbauer effect session was well attended considering it was an evening session. Dr. R. Gerson's paper (FA1) on a piezoelectric drive was interesting but this type of system does not seem to be useful except in very special cases. Paper (FA3) was interesting in that it was not given. Dr. J. Heberle simply said the abstract was adequate and that he was willing to answer questions. There were none.

A new Mössbauer isotope Cs^{133} was reported by the Argonne workers, however the effect is very small, about 0.35 per cent. The other papers were routine and little detailed interpretation was given. This may

be due to the length of the papers or to the lack of theoretical understanding.

On Friday two sessions of invited papers were of interest. The morning session comprised certain solid-state physics topics; the afternoon session dealt with the history of twentieth century physics. The paper on man-made diamonds by C.G. Suits of General Electric was most interesting. The problems of patent and defence contracts were presented as well as some of the industrial uses of the artificial diamonds. A paper on Quantum Electronics by Dr. B. Lax of Lincoln Laboratory was an excellent review of recent advances in masers and their ilk.

The history of physics of this century has recently been studied by a History of Science group of the American Institute of Physics. The speaker described the interesting and exciting work of the group and their contribution to the history of science.

It is difficult to realize how rapidly events become history and how rapidly information is lost. For example, the apparatus used for the Michelson-Morley experiment does not exist although the experiment is less than 70 years old.

The APS banquet speaker was Dr. G.A. Goudsmit the editor of The Physical Review. He discussed publication problems and suggested some cures. He proposed that the journal should split into 5 sections from the present 2; this he considered more acceptable than many smaller special-interest journals.

The apparatus show, held concurrently, occupied the mezzanine floor of the Statler-Hilton; over 100 companies were represented.

Superconducting magnets, lasers and high field magnets were the most prominent items. Several firms offered fast coincidence systems and there was considerable emphasis on multi-parameter,multi-channel analysers. A discussion with Semi-Elements Inc. indicated that they grew sphalerite by vapour transport but were working on a melt system. Isomet indicated that they also used the vapour transport technique for growing ZnS. This firm has also tried melts, but have had no good results for sphalerite.

CONCLUSION

The meetings were rewarding in that personal contact was renewed with other workers on the Mössbauer effect. The field is not advancing as rapidly as it was a few years ago and there is much discussion about the next set of experiments.

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